To evaluate reforestation in farms: A tool for smallholders and the sustainability of their initiatives (EvaRefo).

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Introduction

Tree planting and reforestation are key aspects to consider in the economic and biophysical contexts of Climate Smart Agriculture. Despite academic consensus on the need to reforest agricultural landscapes in order to mitigate and adapt to climate change, the experiences of many small landholders are tarnished by difficulties, which leads to disillusionment and abandonment of reforestation initiatives. Reforestation, as any other natural resources management system (NRMS), requires logical and explicit evaluation methods to assess its performance, prompting the question: ¿How to better account for the sustainability of reforestation initiatives? The objective of this work was to create a practical tool to evaluate the sustainability of reforestation initiatives from a holistic perspective. The tool (EvaRefo) makes the most of scientific and technical knowledge on reforestation conditions and processes, while remaining operationally simple so that small landholders can use it without additional monetary investment nor high-level technical knowledge. The self-evaluation of initiatives facilitates learning and capacity-building directly from the field experience.

Methods

The study was conducted in the Biological Subcorredor of Balalaica, which belongs to the Talamanca Central Volcanic Biological Corridor. Based on records of the Costa Rican Institute of Electricity (ICE) and the database of the National Forestry Financing Fund (FONAFIFO), a total of 53 reforestation initiatives were located.

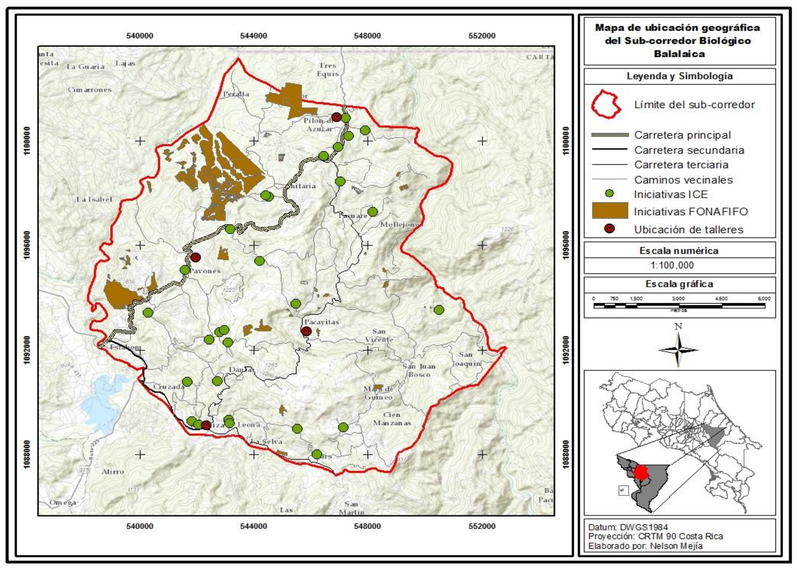
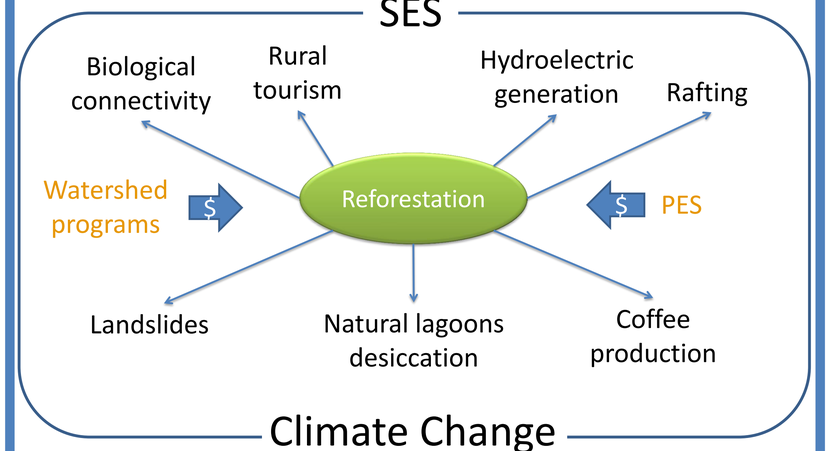


Figure 1. Location of Biological Subcorredor Balalaica in Costa Rica



A set of sustainability indicators was developed, accounting for the values and objectives of local stakeholders.

A series of indicators was proposed based on studies on the evaluation of reforestation initiatives and NRMS by López-Ridaura *et al.* (2002); Keulen *et al.* (2005); Feld *et al.* (2010); Astier *et al.* (2011); Le *et al.* (2012); Oudenhoven *et al.* (2012); and Le *et al.* (2014). The preselected indicators reflect four dimensions of sustainability - economic, ecological, social and cultural - in addition to being practical and easy to monitor.

In four workshops with stakeholders in different locations of Balalaica, reforesters made explicit the benefits they expect from their own initiatives, and linked them to the proposed indicators.

Then a set of indicators was developed on the potential of an initiative and on its performance, so as to synthetically account for observable parameters of importance with respect to the objectives of reforestation in Balalaica.

Table 1. Preselected indicators for evaluating/monitoring reforestation initiatives (**bold on potential**, underlined on performance)

Dimension	Proposed indicator	Description
Economic	Initial investment	Amounts invested initially in tree planting
	Annual investment	Amounts invested during 5 following years
	Net income	Income generated by reforestation (thinning, firewood, touristic attraction)
	Potential income	Increased value of reforested land
	Market clarity	Level of planning and understanding about selling reforestation products
Ecological	Water and soil conservation	Average on soil parameters: colour, leaf cover, erosion, drainage
	Tree growth & quality	A set of tree development parameters
	Wildlife conservation	Planted trees providing a habitat for wildlife
	Site-suitability of tree species	Consistency among reforestation objectives, species requirements, and site potential
Social	**Technical capacities**	Skills obtained by the reforester through experience, training, technical assistance
	Associative capacities	Local organizational level of the reforester
	Self-sufficiency	Independence towards provision of external inputs for establishing and continuing the initiative
	Level of state support	Degree of fulfilment of the role of state institutions
	Local employment generation	Contribution of reforestation to local economy through job creation
Cultural	Cultural acceptance	Planted trees belonging to local customs and provide benefits of common interest

Table 2. Indicator - objective link up in the district of La Suiza

Initiative's objective	Economic					Ecological				Social					Cultural
	II	AI	NI	PI	MC	SC	TD	EW	SS	TC	OL	EID	SS	LE	LC
Capital formation	X	X	X	X	X	X	X			X	X				X
Ecological conservation	X	X					X	X	X	X			X		X
Water source protection	X	X				X	X		X	X	X		X	X	X
Food/family feed/wildlife	X	X	X	X	X		X	X		X				X	
Timber production	X	X	X	X	X		X		X	X	X		X	X	
Recreation	X	X					X	X	X	X	X	X			X
Personal satisfaction	X	X					X	X		X	X	X			X
Resource diversification	X	X	X	X	X	X	X			X			X	X	X
Prevention of landslides and soil erosion	X	X					X		X	X			X		X
Prevention adverse effects to the ecosystem	X	X					X		X	X			X		X
To avoid chemical products	X	X					X			X					
Tourism	X	X					X			X					X

II: Initial investment ; AI: Annual investment; NI: Net income; PI: Potential income; MC: Market clarity

SC: Water & soil conservation; TD: Tree development; EW: Existing wildlife; SS: Site suitability;

Technical capacities (TC); OL: Organizational level; External inputs dependence (EID); Level of state support (SS); LE: Local employment generation

LC: Contribution to local culture

Results

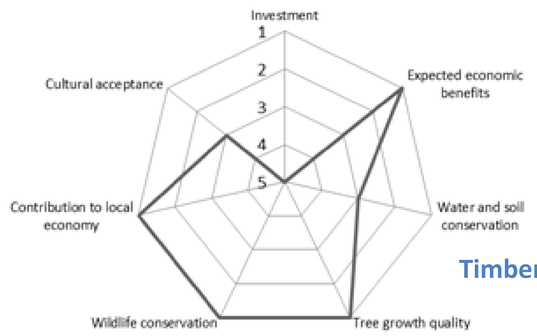
EvaRefo was applied to six initiatives with different objectives: timber production, water conservation, ecological conservation, rural and scientific tourism, agroforestry, and PES. Reforesters were able to observe and measure different parameters with practical methods.

All photos taken by N.Mejía

EvaRefo can be downloaded on ABOMORE's website: http://www.abomore.org/#!recursos/c8nk

Table 3. Evaluating the **potential** of a reforestation initiative: 2 examples

Initiative's objective	Indicators on potentials					Mean
	Site suitability	Associative capacities	Technical capacities	Self-sufficiency	Market clarity	
Timber prod.	1.8	5.0	3.3	1.0	1.0	2.4
Agroforestry	1.5	1.0	3.7	5.0	3.0	2.8



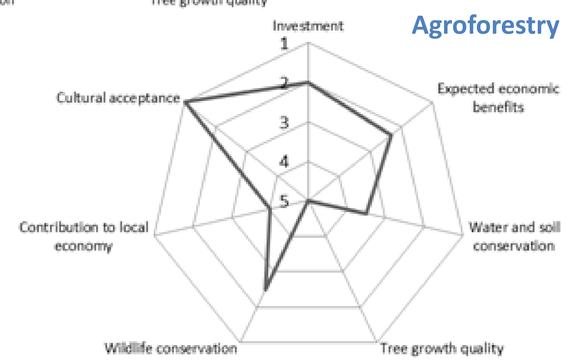


Figure 3. Evaluating the performance of a reforestation initiative: same 2 examples

Conclusions

EvaRefo is a practical assessment tool contributing to the science-society dialogue on the sustainability of reforestation initiatives. Still in its development and validation stage, it should be further tested in the field for its improvement. It has been designed to be transferable to other geographical locations, by simply adjusting the value scale and the parameters of evaluation. EvaRefo can help visualize production and conservation trade-offs, allowing its user to deliberate the results according to his or her interests. At the same time, the tool allows results comparisons among reforestation initiatives with different objectives. The high level of participation and commitment shown by reforesters and other stakeholders (Mejia, 2014) demonstrates their keen interest in the future of their initiatives and in addressing challenges in an associative manner.

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